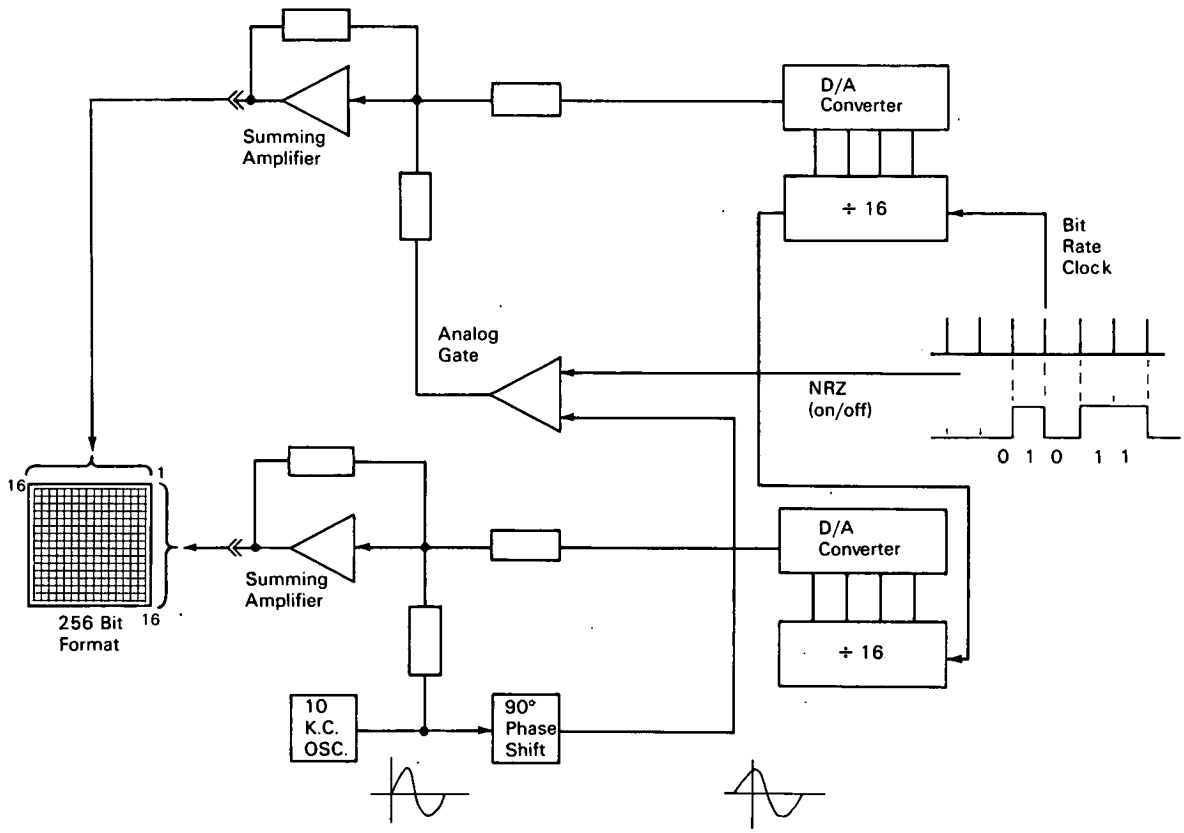
# NASA TECH BRIEF



## Numerical Data Frame Readout System Used in Testing Telemetry Systems




**The problem:**

To test digital telemetry systems; previous techniques used a display light and memory device for each data bit presented, or recording printout devices that were inherently slow, requiring data storage prior to readout in high speed equipment. Oscilloscope raster displays have also been used to present data in non-return-to-zero (NRZ) form rather than numerical form. In all these, certain deficiencies exist. In display light and memory systems, equipment is expensive, data analysis is time consuming, and adaption to real time is difficult. Oscilloscope raster displays are speed limited by the instrument's response and bandwidth characteristics.

**The solution:**

A display system offering direct readout as high data rates in numerical format and adaptable to photographic recording techniques.

(continued overleaf)

**How it's done:**

The system displays a 256-bit rectangular data format with 16 rows and 16 columns assigned to each frame. The system lends itself to expansion or contraction to suit any desired format. The digital-to-analog (D/A) converters are composed of binary weighted resistors referenced by constant current sources that are controlled by 4-bit binary counters. The counters operate in a pure binary sequence (0 to 15) to produce a linear 16-level staircase function at the outputs of the respective D/A converters.

The 10 kc sine wave oscillator is a phase shift type, wherein the peak-to-peak amplitude is less than ½ the least quantized interval of the D/A converters. The 90° phase shift network consists of a simple rc network that is matched to the impedances of both the oscillator and the analog gate. The analog gate is linear with a very low offset voltage that may, in turn, be compensated by a bias. It is used to pass the 90° sine wave component, undistorted, to the operational amplifier summing resistor whenever a voltage level (binary "1") arrives at its control input from the NRZ data. The absence of a voltage level (binary "0"), in turn, inhibits the sine wave and produces a ground level at the gate output. The operational summing amplifiers have frequency response of 0 to 50 kc and open loop gain of 62 db.

In operation, the system forms an oscilloscope raster display generated by bit-to-bit and line-to-line electron beam deflection from staircase sweep signals, where each beam location is coherent with an incoming data bit. Coherence is readily established by clocking the binary counters with the bit rate clock. At each beam location, either a "1" or "0" is formed by generation of Lissajous figures, where the particular pattern is determined by the state of a data bit at the NRZ input. In the case of a "1" (voltage level in NRZ pattern), the vertical input receives a 10 kc sine wave component, while the 90° sine wave component is blanked at the horizontal input. If the data bit interval is 1 millisecond, the electron beam is deflected in a vertical direction over 10 cycles of the sine wave, thus generating a numerical "1" equal in height to the peak-to-peak amplitude of the sine wave. In the presence of a "0" data bit, both vertical and horizontal inputs receive sine wave components, and the 90° displacement in phase angle will cause a numerical "0" to appear. Ten cycles of beam deflection are again encountered for each bit presented, providing ample retrace for use with low persistence or low response time oscilloscopes. Synchronization of readout sequence with incoming data is accomplished by clearing the binary counters at the beginning of the readout sequence.

**Notes:**

1. This display system can be used to show bit dropouts at a memory output or to locate a failure or malfunction in a particular portion of a system. Telemetry system operation can also be checked for errors caused by noise or weak signals in the transmission link, thus determining bit error rates.
2. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland 20771
   Reference: B67-10175

**Patent status:**

No patent action is contemplated by NASA.

Source: John R. Cressey and Charles E. Cote (GSFC-551)